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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
TRINH, THANH TRUC	
ART UNIT	**PAPER NUMBER**
1795	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/573,864	NAGEL, WULF	
	Examiner	Art Unit	
	THANH-TRUC TRINH	1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 September 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-7,9 and 12-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-7,9 and 12-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 recites the limitation "the conductors" in line 10. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. Claims 1-2, 4 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk (US Patent 5828088) in view of Wenham et al. (US Patent 4748130), and further in view of Epstein (US Patent 3664874)

Regarding claims 1 and 4, as seen in Figures 1-3, Mauk teaches a photovoltaic element comprising a photon absorber (including layers GaAs substrate, expitaxial layers p-type cladding layer, p-type base, n-type emitter); an electrically conductive large-surface working element (buried mirrors or reflective mask) made of refractory metals such as tungsten (See col. 7 line 60 through col. 8 line 67), wherein the working element is a parallelepiped (see figures 1A-B and 3) and separated from the photon absorber by a phase boundary (i.e. different material) and has a greater electron mobility than the photon absorber (e.g. as being metal); at least a conductor (see emitter contact or back contact in Figures 1-3), wherein the working element and the at least one conductor is elongate and substantially parallel to each other. Mauk also teaches the photon absorber (or solar cell) can be made with GaAs or silicon (See col. 3 lines 17-20, col. 7 lines 40-49).

Mauk does not teach the conductors embedded in the photon absorber, the volume ratio of the photon absorber to at least one conductor is in the range of 2-7, and the one conductor has essentially the same composition as the working element.

Wenham et al. teaches forming buried contact layers (metallization of grooves 13 as seen in Figure 1, fingers and busbars - See col. 3 line 20 through col. 4 line 55). It would have been obvious to one skilled in the art at the time the invention was made to modify the photovoltaic element of Maulk by having at least one conductor embedded in

the photon absorber as taught by Wenham et al., because Wenham et al. teaches such conductor would reduce the shading area (see abstract of Wenham et al.). Regarding the volume ratio of the photon absorber to the conductors, it would have been an obvious matter of design choice to make the volume ratio in the range of 2 to 7. Gardner v. TEC Systems, Inc., 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), the Federal Circuit held that, where the only difference between the prior art and the claims was the recitation of relative dimensions of the claimed device and a device having the claimed relative dimensions would not perform differently than the prior device, the claimed device was not patentably distinct from the prior device. The skilled artisan would have been able to select an appropriate volume ratio of the photon absorber to the conductors based on the desired properties of the photovoltaic element. Furthermore, modified Mauk but does not explicitly disclose the volume ratio of the photon absorber to the conductors being in the range of between 2 to 7. As the volume ratio is a variable that can be modified by adjusting the number and size of the conductors and more specifically the back conductors (or the back contact) of the photovoltaic elements, with said volume ratio increasing as the number and size of the conductors decreased, the precise volume ratio of the photon absorber to the conductors would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was made. As such, without showing unexpected results, the claimed volume ratio cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was made would have optimized, by routine experimentation, the volume ratio of the photon absorber to the conductors in the apparatus of Beal to obtain

desired number and size of the conductors and specially the back conductors (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

Epstein teaches tungsten can be used as electrical contacts on silicon substrates (See abstract, col. 1 line 4 through col. 3 line 26). It would have been obvious to one skilled in the art at the time the invention was made to have used tungsten as the material for the conductors in silicon photon absorber as taught by Epstein in the photovoltaic element of modified Maulk, because Epstein teaches tungsten would withstand the extreme environment conditions of temperature, humidity, vacuum and radiation (See col. 2 lines 18-20 of Epstein). In such combination, the conductors are made of tungsten which is the same composition as the tungsten working element taught by modified Mauk.

Regarding claim 2, as seen in Figures 1-3, the work element of Mauk is a buried mirror, and is substantially electrically insulated from a positive and a negative pole of the photovoltaic element (e.g. emitter contact or back contact)

Regarding claim 12, metal such as tungsten is from the 3.-6. main group and has electron configuration of d-layer occupied by ten electrons. The conductivity of tungsten is 176.991 x 10^3 $\Omega^{-1}cm^{-1}$ (See Tungsten element facts provided by Chemicool.com) which is inherently higher than 1.4 $\Omega^{-1}cm^{-1}$.

6. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk (US Patent 5828088) in view of Wenham et al. (US Patent 4748130) and Epstein (US Patent 3664874) as applied to claims 12, 4 and 12 above, and further in view of Wenham et al. (US Patent 5595607, hereby '607)

Regarding claim 5, modified Mauk teaches a photovoltaic element as set forth aobve, wherein Wenham et al. teaches a plurality of conductors (e.g. grooves to form front or back contacts- see col. 3 line 20 through col. 4 line 55).

Modified Mauk does not specifically teaches a positive conductor ending at or protruding beyond a first front side of the photon absorber, a negative conductor ending at or protruding beyond a second front side of the photon absorber.

'607 teaches a positive conductor (e.g. metal filled groove 305 connecting to p+ material 308 as seen in Figure 1) ending at a first front side of the photon absorber and a negative conductor (e.g. metal filled groove 309 connecting to n+ material as seen in Figure 1) ending at a second front side of the photon absorber (See figure 1)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the photovoltaic element of modified Mauk by having a positive conductor ending at a first front side of the photon absorber and a negative conductor ending at a second front side of the photon absorber as taught by '607, because '607 such connecting would provide opposite polarity (e.g. positive and negative) interdigitated with each other to minimize photoactive space lost as well as providing a current path to interconnecting grooves which interconnect the photovoltaic cells at the same time providing for low resistance losses. (see col. 4 lines 7-29 of '607)

7. Claims 6-7, 9 and 13-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk (US Patent 5828088) in view of Wenham et al. (US Patent 4748130) and further in view of Epstein (US Patent 3664874) and '607 as applied to claim 5 above, and further in view of Warner (US Patent 3994012)

Modified Mauk teaches a photovoltaic element as described in claims 1 and 5 above, wherein '607 teaches the conductors are embedded in the photon absorber and formed on one side of the photovoltaic element (see Figure 1 of '607)

Modified Mauk does not teach two photon absorbers are in contact via an abutment surface in which the positive conductors are separated from the negative conductors by the abutment surface; or a plurality of positive conductors are connected with each other through an omnibus and a plurality of negative conductors are connected with each other via a second omnibus conductor; or a plurality of photovoltaic elements arranged in a recess wherein the recess is in contact with at least one photon absorber; or two photon absorbers have a mutually anti-parallel crystal structure.

Regarding claims 6-7, as seen in Figures 15-20 and 32-33, Warner teaches a photovoltaic element having a multi-layer structure, wherein at least two absorbers (right and left columns of multilayers of N and P) are provided in contact via an abutment surface (or the bottom surface of interconnection 45 as seen in Figures 15-20) in which the positive conductors (P+ regions next to the interconnection 45) and the negative conductors (N+ regions next to the interconnection 45) are arranged such that the

positive conductors and the negative conductors are separated from each other by the abutment surface, and the plurality of positive conductors are connected with each other through a first omnibus conductor (or interconnection 45 via comb-like extension 62) and a plurality of negative conductors are connected with each other via a second omnibus conductor(or interconnection 45 via comb-like extension 60).

Regarding claims 13-16, as seen in Figures 15-20 and 27-33, Warner teaches a photovoltaic device comprising a receiving element (substrate 40 as seen in Figures 27-33) with recesses in which at least one photovoltaic element (columns of P and N layers) is arranged, wherein conductors (P+ and N+ regions) present in the photovoltaic element are each connected to omnibus conductors (or interconnection 45 as seen in Figures 15-20). Warner also teaches a plurality of photovoltaic elements (absorbers layer of P material and conductors P+ and N+) are arranged in at least one recess, wherein the recess is in contact with at least one photovoltaic element (See Figures 27-33). Warner further teaches a connecting means (interconnection 45) for mechanically and electrically connecting at least two photovoltaic devices arranged side by side, wherein a plurality of first connecting conductors (i.e. comb-like extension 62) and a plurality of second connecting connectors (comb-like extension 60) are each connected with first current conductor (an interconnection 45 as seen in Figure 19) and second current conductor (another interconnection 45 as seen in Figure 19).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the photovoltaic element (or device) of modified Mauk by having absorbers in contact via an abutment surface, absorbers in recesses and

mechanical and electrical connection as taught by Warner, because Warner teaches a photovoltaic cell including all the limitations disclosed by Warner and recited above would increase cell efficiency. (See Abstract of Warner).

With respect to claim 9, Warner teaches connecting a plurality of single crystalline semiconductors of photovoltaic cells by series/parallel connection (See Abstract, col. 16 lines 55-68). In such connection of single crystalline photovoltaic cells, the two photon absorbers obviously have mutual anti-parallel crystal structure. It would have been obvious to connect single crystalline photovoltaic cells of modified Mauk in series/parallel as taught by Warner to achieve a mutually anti-parallel crystal structure, because Warner teaches such connection is suitable configuration. (See col. 16 lines 55-68).

8. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mauk (US Patent 5828088) in view of Wenham et al. (US Patent 4748130) and further in view of Epstein (US Patent 3664874) as applied to claim 1, and further in view of Lidorenko et al. (US Patent 4174978)

Regarding claim 17, modified Mauk teaches a photovoltaic element as set forth above, wherein Mauk teaches using silicon as the material for the absorber (See col. 3 lines 17-20, col. 7 lines 40-49).

Modified Mauk does not teach the photon absorber is substantially made of anisotropic monocrystalline silicon.

Lidorenko et al. teaches using monocrystalline silicon (or silicon wafer, plate) having surfaces oriented along <100> (see col. 10 lines 45-56). A monocrystalline silicon having surface oriented along <100> is substantially anisotropic.

It would have been obvious to one skilled in the art at the time the invention was made to modify the photovoltaic element of modified Mauk by using substantially anisotropic monocrystalline silicon as taught by Lidorrenko et al., because Lindorenko et al. finds it is suitable material in solar cell (see col. 10 lines 45-56), and modified Mauk suggests using silicon (see col. 3 lines 17-20 and col. 7 lines 40-49 of Mauk)

Response to Arguments

9. Applicant's arguments filed 10/27/2009 have been fully considered but they are not persuasive.

Applicant argues that Wenham does not teaches the volume ratio of photon absorber to the conductors in the range of 2 to 7 because the disclosed finger spacing of 1.5-2.5 μm in col. 4 lines 1-3 is wrong. Applicant argues that the W_g is already 100 μm therefore the finger spacing must be bigger than the groove width. However, Applicant's arguments are not deemed to be persuasive. First of all, the finger spacing does not depend on the width of the finger. The finger spacing can be the distance between an edge of one finger and closer edge of the adjacent finger, but not from the center of one finger to the center of the adjacent finger. Secondly, assuming the disclosed spacing of 1.5-2.5 μm in Wenham was an error because Wenham discloses a finger spacing of 1.8 mm afterward, the volume ratio of photon absorber to the

conductors (as in term a plurality of conductors) can be still in the range of 2 to 7 depending on the number of the conductors in a photon absorber and the dimension of the back conductors which is not limited to the dimension disclosed by Wenham. For example, assuming the photon absorber has a thickness of 600 μm and width of 1850 μm (the spacing of 1.8 mm added to the finger width of 50μm, see col. 4 lines 8-17), there is one finger as the front electrode having a width of 50μm and a depth of 150 μm, the back conductor covers the entire surface of the photon absorber thereby having a width of 1850 μm (as similar to the photon absorber) and a typical thickness of 0.15 mm or 150 μm (as seen in the evidentiary reference to Makita et al., US 2003/0075211, paragraph 0075, the thickness of the back electrode of stainless steel plate is 0.15 mm). The volume ratio is reduced to cross section area ratio since the lengths (from the front of page to the back of page) are assumed to be equal. The volume ratio = the cross section ratio = (600 μm x 1850 μm) / [(50μm x 150 μm) + (150μm x 1850 μm)] = 3.894, which is well within the range of 2 to 7. Furthermore, it would have been an obvious matter of design choice to make the volume ratio in the range of 2 to 7. Gardner v. TEC Systems, Inc., 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), the Federal Circuit held that, where the only difference between the prior art and the claims was the recitation of relative dimensions of the claimed device and a device having the claimed relative dimensions would not perform differently than the prior device, the claimed device was not patentably distinct from the prior device. The skilled artisan would have been able to select an appropriate volume ratio of the photon absorber to the conductors based on the desired properties of the photovoltaic element. Furthermore, modified Mauk but

does not explicitly disclose the volume ratio of the photon absorber to the conductors being in the range of between 2 to 7. As the volume ratio is a variable that can be modified by adjusting the number and size of the conductors and more specifically the back conductors (or the back contact) of the photovoltaic elements, with said volume ratio increasing as the number and size of the conductors decreased, the precise volume ratio of the photon absorber to the conductors would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was made. As such, without showing unexpected results, the claimed volume ratio cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was made would have optimized, by routine experimentation, the volume ratio of the photon absorber to the conductors in the apparatus of Beal to obtain desired number and size of the conductors and specially the back conductors (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to THANH-TRUC TRINH whose telephone number is (571)272-6594. The examiner can normally be reached on 8:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

TT
12/7/2009

/Basia Ridley/
Supervisory Patent Examiner, Art Unit 1795